COOKSTOWN - INNISFIL CREEKS
WATER QUALITY SURVEY
1980

By

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SUMMARY

The water quality survey of Cookstown Creek and Innisfil Creek was carried out to provide background information in anticipation of an application for a certificate of approval for a proposed water pollution control plant for the Village of Cookstown.* The data from this report would be used eventually to set preliminary effluent guidelines for this plant.

Cookstown and Innisfil Creeks support a fishery consisting mainly of bait fish. The predominant stream water use is for irrigation and there are several locations on Innisfil Creek where water is extracted for this purpose. The approved combined maximum rate of extraction could amount to the major portion of the flow in the stream during the low flow period. Although not observed, there is cattle watering from the streams.

The water quality for both streams met the Provincial Water Quality Objectives or Guidelines for some parameters and violated others. Total phosphorous concentrations were particularly high, and the geometric mean bacteria densities exceeded the objectives for body contact recreational uses. The waters were alkaline and combined with high temperatures, an ammonia rich effluent input could cause exceedence of the objective for un-ionized ammonia.

Cookstown Creek is not a suitable receiver for the treated effluent from the proposed water pollution control plant because of the lack of stream flow. During dry periods, zero flows do occur, e.g., on July 15, 1980 at Station 2 (02ED110). Innisfil Creek is a more suitable receiver because of greater flows. The minimum average day flow for 1980 was 124 litres per second at Station 6 (02ED109); but since the 1980 summer-fall flows were higher than normal, based on the flow records for Station 02ED003 on the Nottawasaga River at Baxter (1948-1980), during years drier than 1980, lower flows could be expected. Then again, the major portion of the flow could be utilized for irrigation.

*A proposal for a 680 m^3/day plant was received by the Ministry soon after the completion of the draft report. The outfall for the plant will be on Innisfil Creek at the 14th Concession Road of West Gwillimbury Township (Station #5 in this report).

The effluent from the proposed plant would require a high degree of treatment to maintain a water quality in the receiving stream consistent with the Provincial Water Quality Objectives. Of the effluent quality parameters, ammonia is of prime concern because of its toxicity to fish. Similarly, chlorine is of concern if it will be used as the disinfecting agent.

INTRODUCTION

The Cookstown-Innisfil Creeks Water Quality Survey, 1980 was carried out to establish the existing water quality in the basin. Prior to this survey, there was little or no information on either water quality or stream flow rates. This report will provide background information to set preliminary guidelines for the treated effluent from a proposed water pollution control plant to service the Village of Cookstown. The proposed outfall for the water pollution control plant will be on either Cookstown Creek or Innisfil Creek; the exact location is unknown as the application for approval of this facility has not yet been received by this Ministry.* The Village of Cookstown is at the intersection of the Townships of Tecumseth, West Gwillimbury, Innisfil and Essa, i.e., at the intersection of Highway No. 89 and Highway No. 27.

This report will indicate the availability of flows at two stream locations, one on Cookstown Creek and the other on Innisfil Creek.

The stream sections surveyed were Cookstown Creek and Innisfil Creek to the first concession downstream of the Cookstown Creek confluence (Figure 1).

*A proposal for a 680 m^3/day plant was received by the Ministry soon after the completion of the draft report. The outfall for the plant will be on Innisfil Creek at the 14th Concession Road of West Gwillimbury Township (Station #5 in this report).

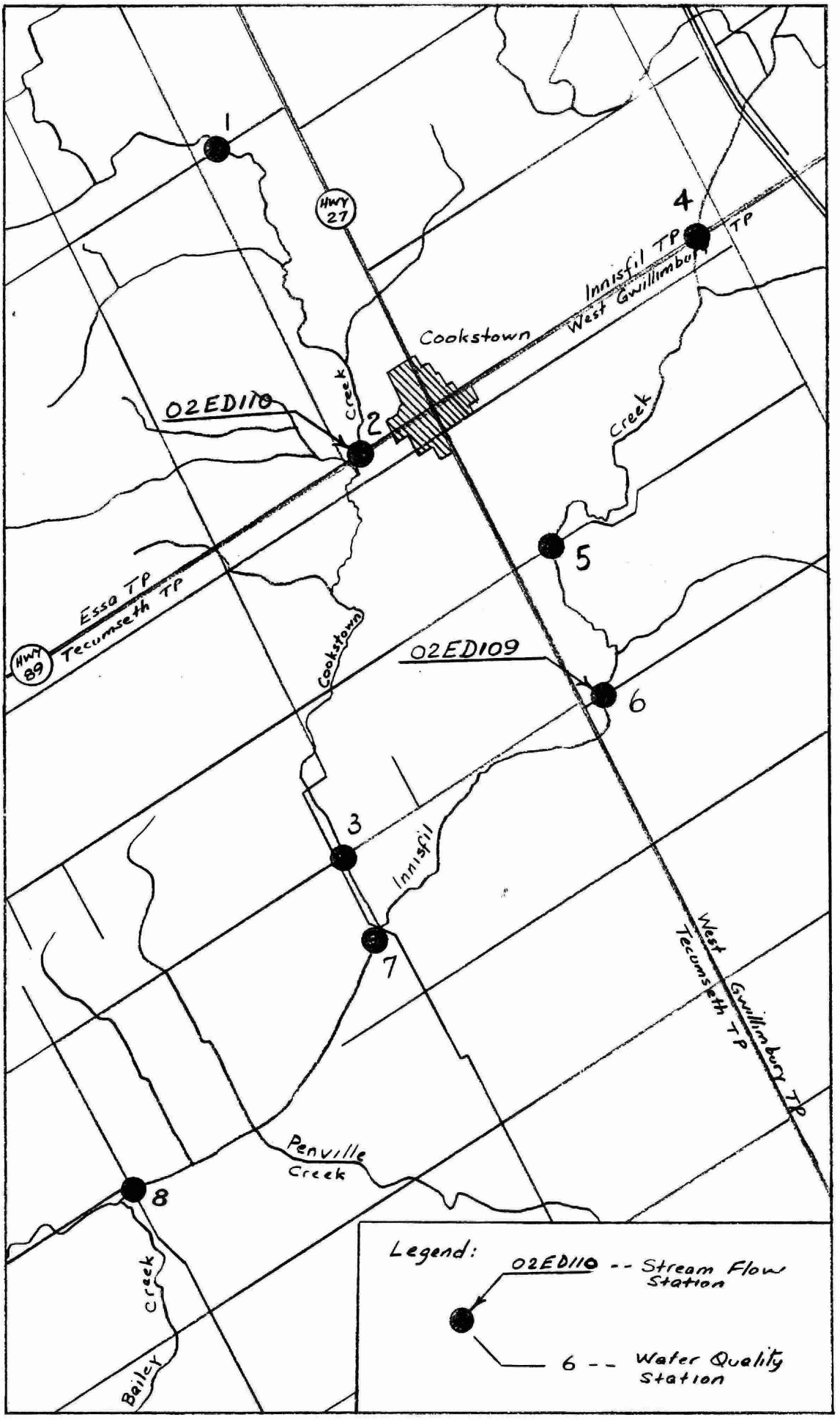

Figure 1-- Cookstown-Innisfil Creek Water Quality, 1980: Monitoring Network.

MONITORING NETWORK AND PARAMETERS

The water quality monitoring network for the 1980 survey consisted of eight stations, three on Cookstown Creek and five on Innisfil Creek (Figure 1).

During the period from May to August, 1980, eight sampling runs were accomplished. The water samples were analyzed for the following physical, chemical and bacteriological parameters.

Physical	Chemical	Bacteriological
pH	total phosphorus	total coliform
total solids	soluble reactive phosphorus	fecal coliform
suspended solids	ammonia nitrogen	fecal streptococcus
conductivity	total Kjeldahl nitrogen	
	nitrite nitrogen	
	nitrate nitrogen	
	chlorides	
	five-day biochemical oxygen demand (BOD_5)	

In situ dissolved oxygen concentrations and temperatures were measured at each site on each sampling visit. Two of the sample runs were carried out at night-time to determine whether or not plant respiration had an impact on stream dissolved oxygen concentrations. On at least four occasions, in situ stream pH's were meausured. During the June 10, 1980 sampling run, stream water samples were also collected and analysed for heavy metals, polychlorinated biphenyls, and organochlorine pesticides concentrations.

Two stream flow recording guages were installed, at Station 2 (02ED110) on Cookstown Creek and at Station 6 (02ED109), on Innisfil Creek. These stations were operated from April to November, 1980.

DESCRIPTION OF BASIN, STREAM CHARACTERISTICS AND THE LAND AND WATER USES

Cookstown Creek flows through morainic deposits of sand, silt and clay tills. There are also several drumlins in this basin. Innisfil Creek flows through bar deposits of coarse sands and gravels in its headwater areas. For the lower third of its length upstream of the Cookstown Creek confluence, it flows through fine-grained lacustrine and pond deposits, and for the section from approximately the Cookstown Creek confluence to its exit from the basin, through swamp deposits.

Most of the lands in the basin, including those immediately adjacent to the streams, are used for agricultural purposes. The Village of Cookstown is the only centre of concentrated population in the basin. According to the 1980 Municipal Directory, the 1979 population for Cookstown was 836.

During the period June 4 to 9 and July 15 to 17, 1980, the streams were "walked" to obtain information on stream and flow characteristics, and land and water uses. This information is shown in Table 1.

Cookstown Creek drains a small area. During dry periods the flow is generally less than 15 litres per second. Because of these flows, the stream width was less than two meters and its depth 20 centimeters. Stream velocities were less than 30 centimeters per second. The bed materials consist mostly of gravels and sands. Aquatic plant cover of the stream bed was extensive and averaged about 30 per cent. No stream water uses were observed; but cattle watering was evident. There are no structures on the stream to significantly impede or restrict flows.

Innisfil Creek is much larger than Cookstown Creek. The average stream width was 3 meters and the depth about 30 centimeters. Stream velocities were fast in some stretches and slow in others. Unlike Cookstown Creek, the bed materials consisted of sand and silt. Plant cover in the stream bed averaged about 10%. No water extractions were observed during the "walks". Between Stations 5 and 6, five beaver dams were observed.

Table 1

Cookstown-Innisfil Creek Water Quality Survey, 1980;
Stream Characteristics, and Water and Land Use

Stream Section (Station to Station)	Width (m)	Depth (cm)	Flow * Description	Bed Material	Aquatic Plant Cover (%)	Adjacent Land Use	Water Extraction	Comments
1 to 2	1.2	14	slow	stones, gravel & sand	60	agriculture & cattle farming	None	Small dam & reservoir south of Station 1.
2 to 2½	2.1	64	slow	stones, gravel & sand	35	agriculture & cattle farming	None	On-stream pond, 75m x 75m mid-way between Stations 2 and 3
2½ to 7	1.5	15	fast	gravel, sand & silt	10	agricultural	None	
4 to 5	3.0	40	slow	sand & silt	25	agricultural	Two for irrigation	Max. rate: 4400 L/min
5 to 6	3.5	20	fast	sand & silt	10	agricultural	One for irrigation	five beaver dams Takings included in above
6 to 7	3.5	50	slow	sand & silt	15	agricultural & cattle farming	None	
7 to 8	4.5	30	fast	sand, gravel & silt	L10	agricultural & cattle farming	One for irrigation	Max. rate: 1630 L/min

L = less than

* Slow - velocity 30 cm/sec.
Fast - velocity 30 cm/sec.

The fishery in Cookstown Creek consists mainly of bait fish, e.g., minnows. There is a cold-water fishery in the headwaters of Innisfil Creek, well upstream of Station 4. In the area surveyed, the fishery is similar to that in Cookstown Creek, i.e., bait fish.

Apart from the observations of water uses during the stream "walk", our Permit To Take Water files indicate that there are nine permits to extract water from surface sources within the survey area (Figure 2). Five allow for the ponding of stream flow for recreational purposes. Since the ponding usually occurs during high flow periods, disruptions of normal stream uses by this type of taking are minimal. The other four permits allow for the extraction of stream water for irrigation. Since irrigation usually coincides with the low flow periods, the extraction of stream flow for irrigation can reduce stream flows substantially.

In the Cookstown Creek sub-basin, there are two permits, one for recreation and the other for irrigation. Since the permit for irrigation waters allows for the taking of water into storage only during relatively high flow periods, the impact on downstream flow rates should be small.

Of the seven permits in the Innisfil sub-basin, three are for irrigation. There are no permits for Innisfil Creek upstream of Station 4. Between Stations 4 and 6 there are six permits, of which two are for irrigation and four for recreation. These two permits for irrigation allow for the extraction of water at seven locations, two of which are on Innisfil Creek between Stations 4 and 5. The combined maximum allowable rate of extraction for these two permits are 65 L/sec. and 1,830,000 L/day (866 gpm and 624,000 gpd). At this time, it is not possible to determine what fraction of the total water will be extracted upstream or downstream of Station 5. In its management of streamflow allocation during low flow periods, the Ministry normally cuts back approved takings to one-third of the streamflow in order to provide flow for other uses. The point of extraction for the third permit for Innisfil Creek is located immediately downstream of Station 7.

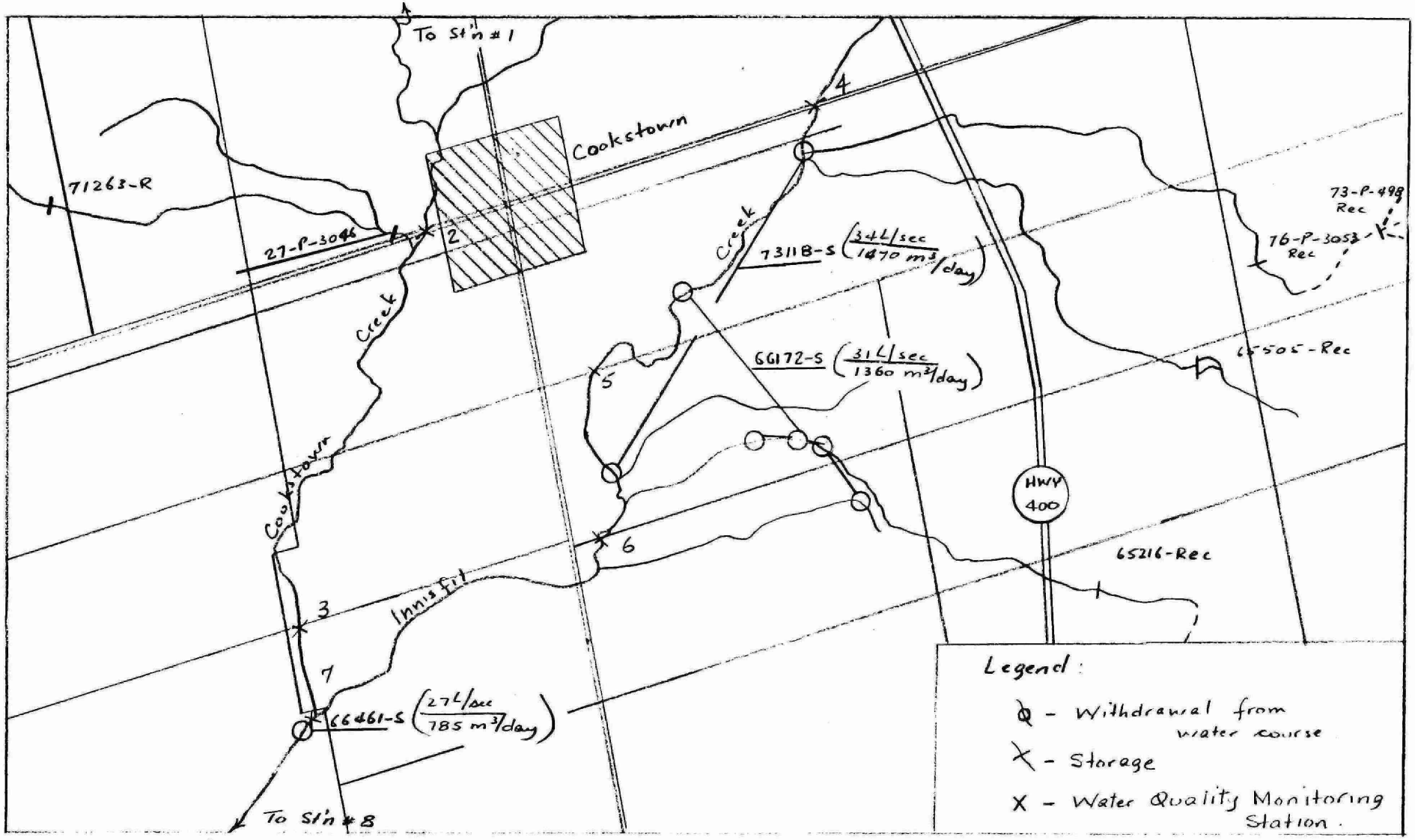

Figure 2 -- Cookstown-Innisfil Creek Water Quality Survey, 1980; Permits To Take Water from Surface Sources.

WATER QUALITY DATA AND DISCUSSION

The water quality in both Cookstown and Innisfil Creeks as found during the survey met the Provincial Water Quality Objectives for dissolved oxygen, un-ionized ammonia and pH. The suggested guideline for total phosphorous was exceeded at all stations. The body-contact recreational use objectives for bacteria were exceeded at most stations. The other water quality parameters dealt with in this report within acceptable ranges. The water quality data collected for the survey are contained in Appendices 1 to 8.

The following is a general discussion of the water quality parameters found during the survey. The relation of the parameters to the three prime uses identified in previous sections will be emphasized, i.e. fish habitat, irrigation and cattle watering.

The mean dissolved oxygen concentrations at all stations satisfied the objective for a warm water fishery, i.e., a minimum of 4.0 mg/L at 25°C. The average day-time concentrations at all stations exceeded 8.0 mg/L, and the night-time concentrations ranged between 6.0 mg/L to 7.0 mg/L. The difference between day-time and night-time concentrations indicated that plant respiration impact on the stream dissolved oxygen concentrations did not adversely affect the fishery.

Five-day biochemical oxygen demand (BOD_5) concentrations were low and at most stations averaged 1.0 mg/L or less. This Ministry does not have a stream objective for BOD_5. Based on our experience, if the BOD_5 in a flowing stream is 4.0 mg/L or less, dissolved oxygen depletion problems have not been encountered.

Phosphorous is considered the limiting nutrient for aquatic plant growth in flowing streams. Concentrations at all stations did not meet the suggested stream guideline of 0.03 mg/L for total phosphorous. At concentrations greater than this, excessive plant growths may materialize. At average concentrations ranging from 0.096 mg/L at Station 1 to 0.196 mg/L at Station 8, the waters in both Cookstown and

Innisfil Creeks can be considered highly enriched (Figure 3). The enriched nature manifested itself in the abundant aquatic plant growth in the stream bed as observed during the stream "walks". The cause of this enrichement was not investigated; but was suspected to have been related to the widespread agricultural and cattle farming activities in the basin. It is important to note the high soluble reactive phosphorous fractions which is the form most readily available to plants.

The total nitrogen concentrations in Cookstown and Innisfil Creeks were within acceptable ranges (Figure 4). There is no stream objective or guideline for total nitrogen but it is generally accepted that waters with a total nitrogen of 10 mg/L or less are suitable for most uses. The mean total nitrogen concentrations at all stations were generally less than 2.0 mg/L.

Of the four compounds of nitrogen illustrated in Figure 4, two are considered toxic. The un-ionized fraction of ammonia nitrogen (NH_3) is strongly toxic to many fish at concentrations greater than 0.5 mg/L. The Provincial Water Quality Objective is 0.02 mg/L. The un-ionized portion is dependant upon and varies directly with pH and temperature. For this survey, the objective was satisfied at all stations.

There are no stream quality objectives for the other three compounds of nitrogen. Nitrite nitrogen is toxic and is very unstable. Concentrations of less than 0.1 mg/L are normally found in streams and are not toxic. The limit for drinking water is about 2.0 mg/L and tests on minnows revealed that 50 mg/L could be fatal in 14 days. Based on the foregoing the average nitrate nitrogen concentrations (0.014 - 0.030 mg/L) in both Cookstown and Innisfil Creeks were within acceptable ranges.

Nitrate nitrogen is utilized by aquatic plants. In un-polluted streams, concentrations of 0.5 mg/L or less are encountered. The concentrations found during the survey ranged between 0.5 mg/L to 1.0 mg/L and were probably reflective of the adjacent agricultural land uses.

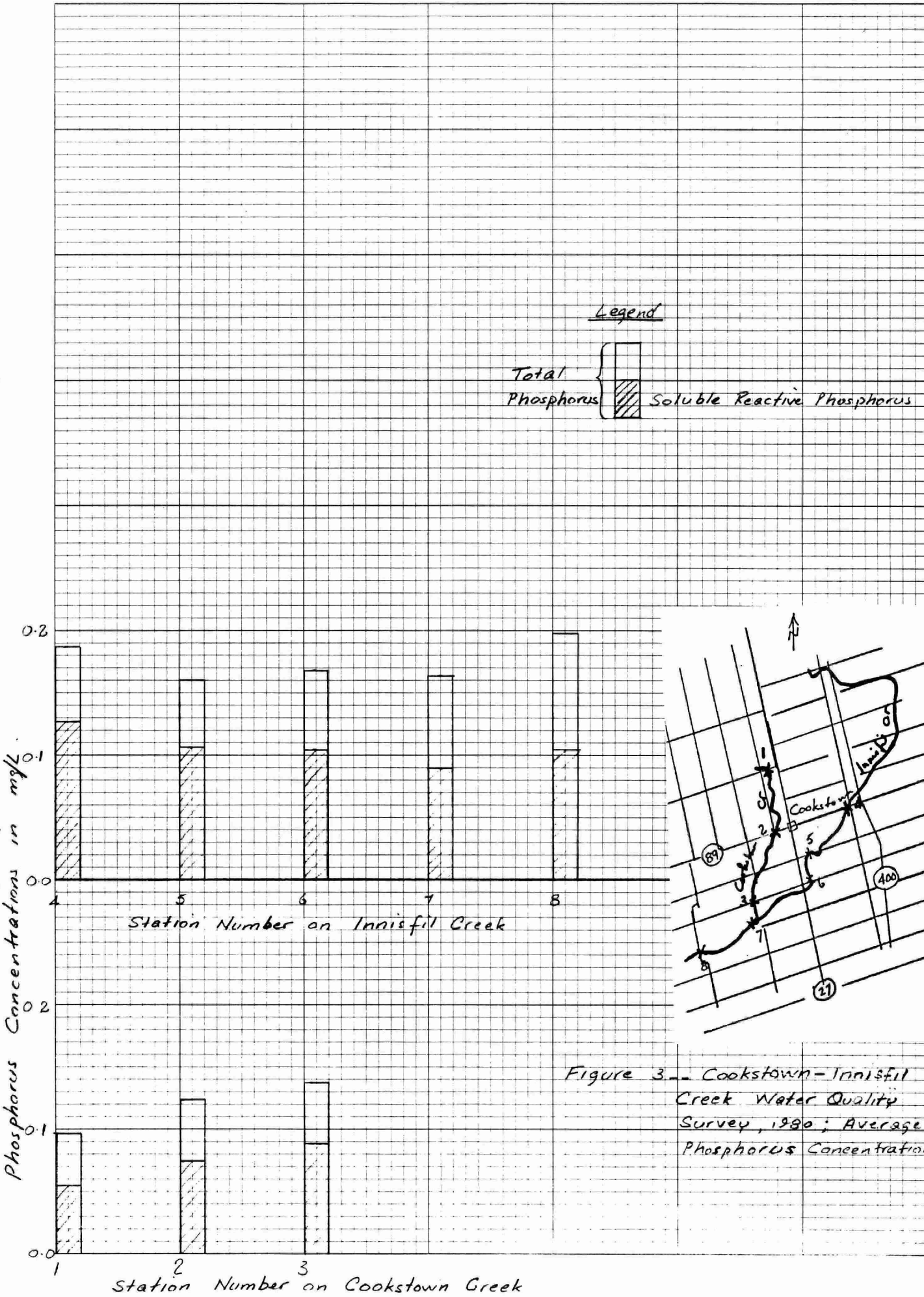

Figure 3 -- Cookstown-Innisfil Creek Water Quality Survey, 1980; Average Phosphorus Concentrations

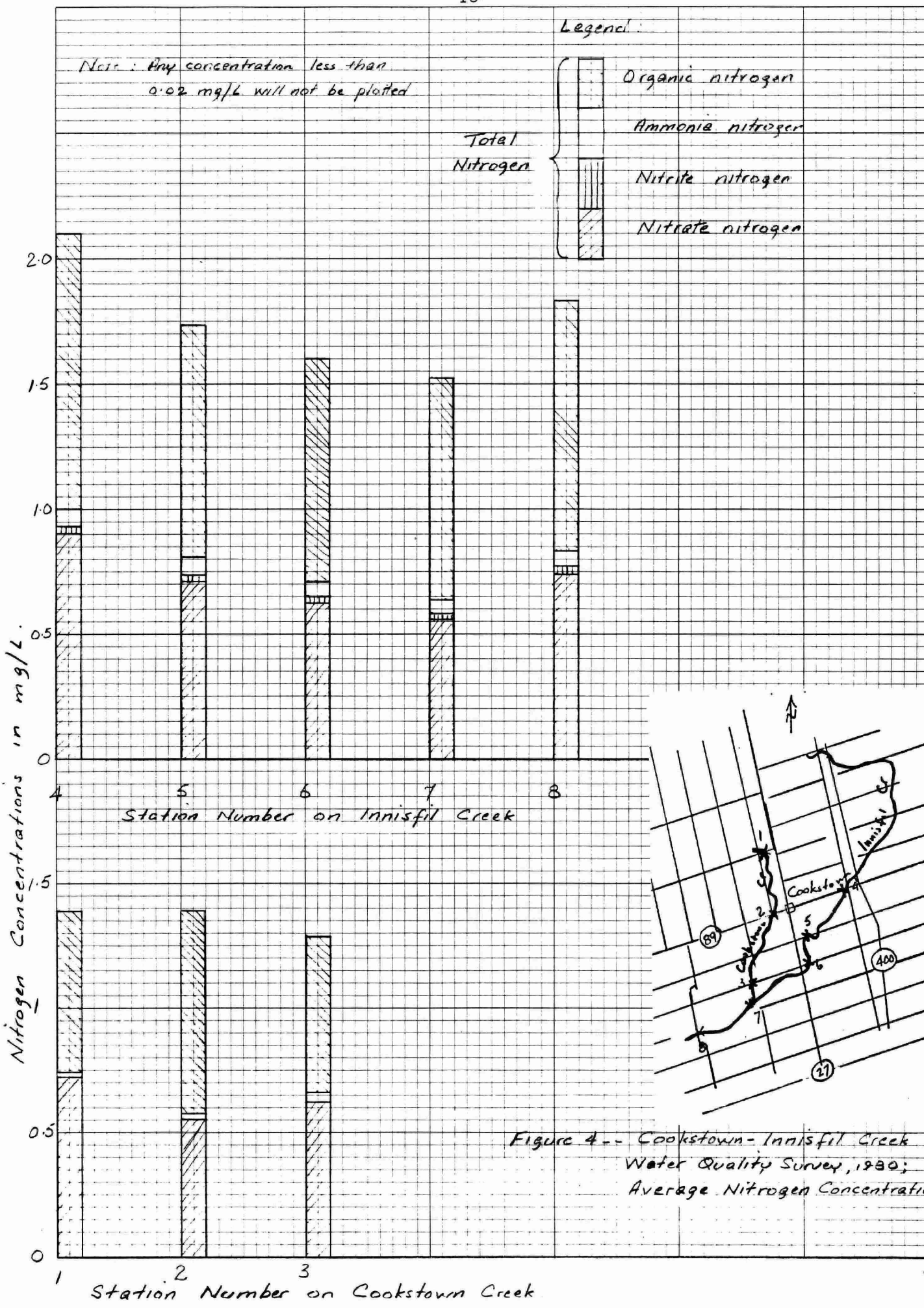

Figure 4 -- Cookstown-Innisfil Creek Water Quality Survey, 1980; Average Nitrogen Concentrations

High concentrations of total solids (suspended and total dissolved) in stream water are undesirable for fish and aquatic life, recreation and aesthetics. In addition, solids act as the transportation mechanism for a variety of pollutants. There is no numerical Provincial Water Quality Objective for solids.

A suspended solid concentration of 30 mg/L is not considered harmful to fish life. Concentrations up to 80 mg/L will provide a moderate level of protection and only minor mortality can be expected. The suspended solids concentrations in Cookstown Creek and Innisfil Creek upstream of the Cookstown Creek confluence as found during the survey will afford a high level of protection; the concentrations in Innisfil Creek downstream of the Cookstown Creek confluence will provide a moderate level of protection.

The dissolved solids portion contain constituents such as carbonates, sulphates, chlorides, phosphates and nitrates which cause osmotic stress in adult fish. Also, high dissolved solids can render water unacceptable for ingestion. In general, dissolved solid concentrations up to 500 mg/L are considered acceptable for most uses. The concentrations for both streams are within this acceptable range.

The chloride concentrations in both streams were not sufficiently high to be harmful to aquatic life, nor to detract from the use of these waters for irrigation or cattle watering. Of the three uses of stream water identified in this basin, the chloride limit for irrigation is most stringent, e.g., for most crops, concentrations up to 150 mg/L are acceptable; but for tobacco, a crop grown in the Nottawasaga River Basin, the limit is 70 mg/L. The chloride concentrations for both basins as found during the survey were within the 70 mg/L limit.

pH is a measure of the alkalinity or acidity of waters. The Provincial Water Quality Objective for pH is in the range from 6.5 to 8.5 for swimming. It should also be noted that pH's within this range are not harmful to fish and other aquatic life. All pH's measured during this survey were within the acceptable range; but values tended to be on the

high end of the scale. The average value for the stations was about 8.0 pH units. As stated earlier, ammonia toxicity varies directly with increasing pH's and at the alkaline values measured and the warm temperatures that can occur, the waters in both Cookstown and Innisfil Creeks will be sensitive to the input of ammonia-rich effluents.

Conductivity (or specific electrical conductance) is a measure of the dissolved ions in solution such as chloride, sulphate, and calcium. High conductivity in waters may be harmful to living organisms because of the increase in osmotic pressures. For irrigation waters and in streams with good mixed fish fauna, levels up to 2,000 umhos/cm at 25°C is acceptable. Relative to this conductivity limit, the levels found during this survey averaged from 560 umhos/cm to 670 umhos/cm.

The geometric mean density for bacteria for most stations exceeded the Provincial Water Quality Objectives for body contact recreational use of 1,000 per 100 mL for total coliform and 100 per 100 mL for fecal coliform. The ratios of the geometric mean densities for fecal coliform to fecal streptococcus did not reveal the origin of this bacterial contamination, except at Station 1 on Cookstown Creek. At Station 1, the ratio suggested the source to be of animal origin other than human.

Stream water samples were collected on June 10, 1980 at each station to determine the concentrations of eight heavy metals. The results of the analyses are tabulated in Table 2. Only the iron concentrations did not meet the Provincial Water Quality Objective at some stations. Whether or not the concentrations for copper, cadmium and lead met the objectives were uncertain because of the lack of precision of the analytical results. In general the concentrations of the heavy metals founds were within the normal ranges for streams.

Stream water samples were also collected on June 10, 1980 for the analyses of polychlorinated biphenyls (PCB's) and organochlorine pesticides (Table 3). PCB's were found at Station 2 only and at a very low concentration. The reported value of 0.020 ug/L may be an analytical anomaly. No further sampling was conducted to confirm this value. The concentations for the organochlorine pesticides were considered to be within the range indicative of streams in agricultural areas.

Table 2

Cookstown-Innisfil Creek Water Quality Survey, 1980;
Heavy Metal Concentrations (June 10)

Station	Zinc (mg/L)	Copper* mg/L	Nickel (mg/L)	Lead* mg/L	Cadmium (mg/L)	Chromium (mg/L)	Manganese (mg/L)	Iron (mg/L)
1	0.01	0.01	0.02	0.03	0.005	0.02	0.04	0.18
2	0.01	0.01	0.02	0.04	0.005	0.02	0.03	0.16
3	0.01	0.01	0.02	0.03	0.005	0.02	0.05	0.34
4	0.01	0.01	0.02	0.03	0.005	0.02	0.06	0.28
5	0.01	0.01	0.02	0.03	0.005	0.02	0.06	0.37
6	0.01	0.01	0.02	0.03	0.005	0.02	0.07	0.46
7	0.01	0.01	0.02	0.04	0.005	0.02	0.09	0.94
8	0.01	0.01	0.02	0.04	0.005	0.02	0.04	0.42
Provincial Water Quality Objective	0.030	0.005	0.025	0.025**	0.0002	0.100	0.50***	0.300

* The detection limits for copper and lead are greater than the Provincial Water Quality Objectives.

** For alkalinity (as $CaCO_3$) 80 mg/L.

*** McKee & Wolf (1963); 0.5 mg/L for irrigation and 1.0 mg/L for fish and aquatic life.

REPT 5-I-2

Table 3

Cookstown-Innisfil Creek Water Quality Survey, 1980;
Polychlorinated Biphenyls (PCB's) and Organochlorine Pesticides

Station	PCB's (ug/L)	a-BHC (ug/l)	Hept. Epoxide (ug/L)	pp.DDE (ug/L)	-Chlordane (ug/L)
1	X	0.020	0.002	0.009	0.005
2	0.020	X	X	X	0.001
3	X	0.001	X	X	X
4	X	X	X	X	X
5	X	0.001	X	X	X
6	X	0.001	X	X	X
7	X	0.001	0.005	X	X
8	X	X	0.005	X	X
Provincial Water Quality Objective	0.001	-	0.001	0.003*	-

N.B. Analysis were also done for HBC, Lindane, -BHC, Heptachlor, Aldrin, Thiodan 1, Thiodan 11, Dieldrin, Endrin, op DDD, pp DDT, -Chlordane and Mirex; all concentrations were non-detectable.

* Objective for DDT and metabolites.

REPT 5-I-3

STREAM FLOWS AND DISCUSSIONS

As stated previously, two temporary stream flow recording stations were established in the survey basin (Figure 1). To determine whether the 1980 summer flows at these stations were above normal, normal or sub-normal, the records for Station 02ED003 on the Nottawasaga River near Baxter were reviewed.

Based on the comparison of the 1980 summer-fall monthly average flows to those for other years on record for Station 02ED003 on the Nottawasaga River at Baxter (1948-1980), it was concluded that 1980 summer-fall stream flows in the Upper Nottawasaga River Basin including those in Innisfil and Cookstown Creeks were above normal. For Station 02ED003, the 1980 average June flow was about average; those for July, August and October were the second highest on record, and that for September was the highest on record.

Station 02ED110 was located on Cookstown Creek at quality Station 2. This station was operational from May 13 to November 27, 1980, and the data obtained was 97 per cent complete (Figure 5). The lowest recorded daily average flow was less than 3 L/sec. Of the 133 daily average flows, five were less than 3 L/sec, seven less than 5 L/sec. and 29 less than 10 L/sec. As stated earlier, there are no known water extraction from Cookstown Creek to reduce flows.

Station 02ED109 was located on Innisfil Creek at quality Station 6. This station operated from April 19 to November 27, 1980, and the data obtained was 85 per cent complete (Figure 6). The lowest daily average flow was 124 L/sec. Of the 192 daily average flows on record, five were less than 125 L/sec., 19 less than 150 L/sec. and 49 less than 200 L/sec.

Unlike Cookstown Creek, there are two permits upstream of Station 02ED109 to extract water for Innisfil Creek for irrigation. The combined maximum allowable extraction rate is 65 L/sec. or more than 50 per cent of the minimum flow recorded at Station 02ED109 during 1980.

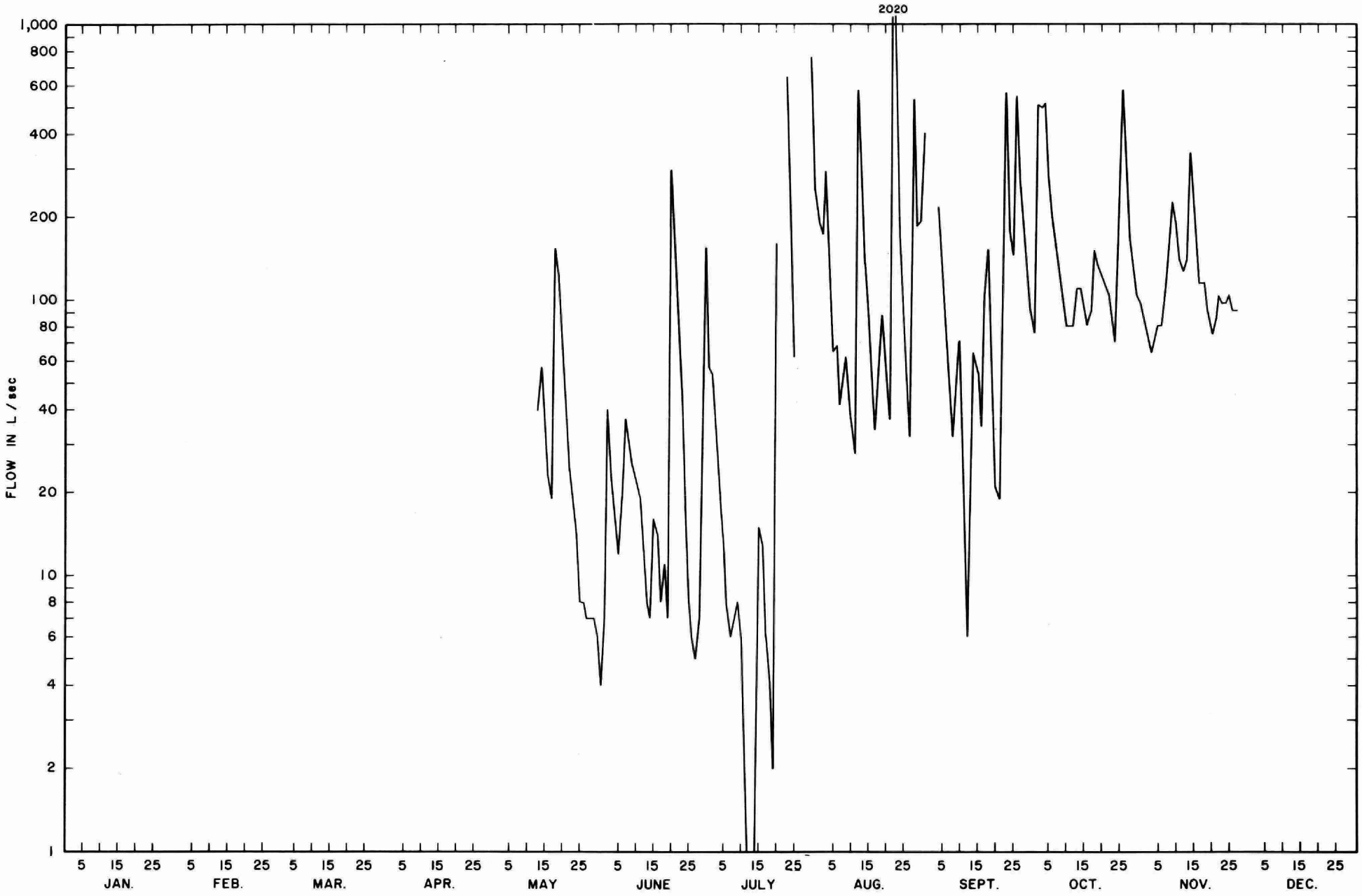

FIGURE 5 - COOKSTOWN-INNISFIL CREEK WATER QUALITY SURVEY, 1980; HYDROGRAPH OF DAILY AVERAGE FLOWS FOR STATION 02ED109 ON COOKSTOWN CREEK AT COOKSTOWN; 1980.

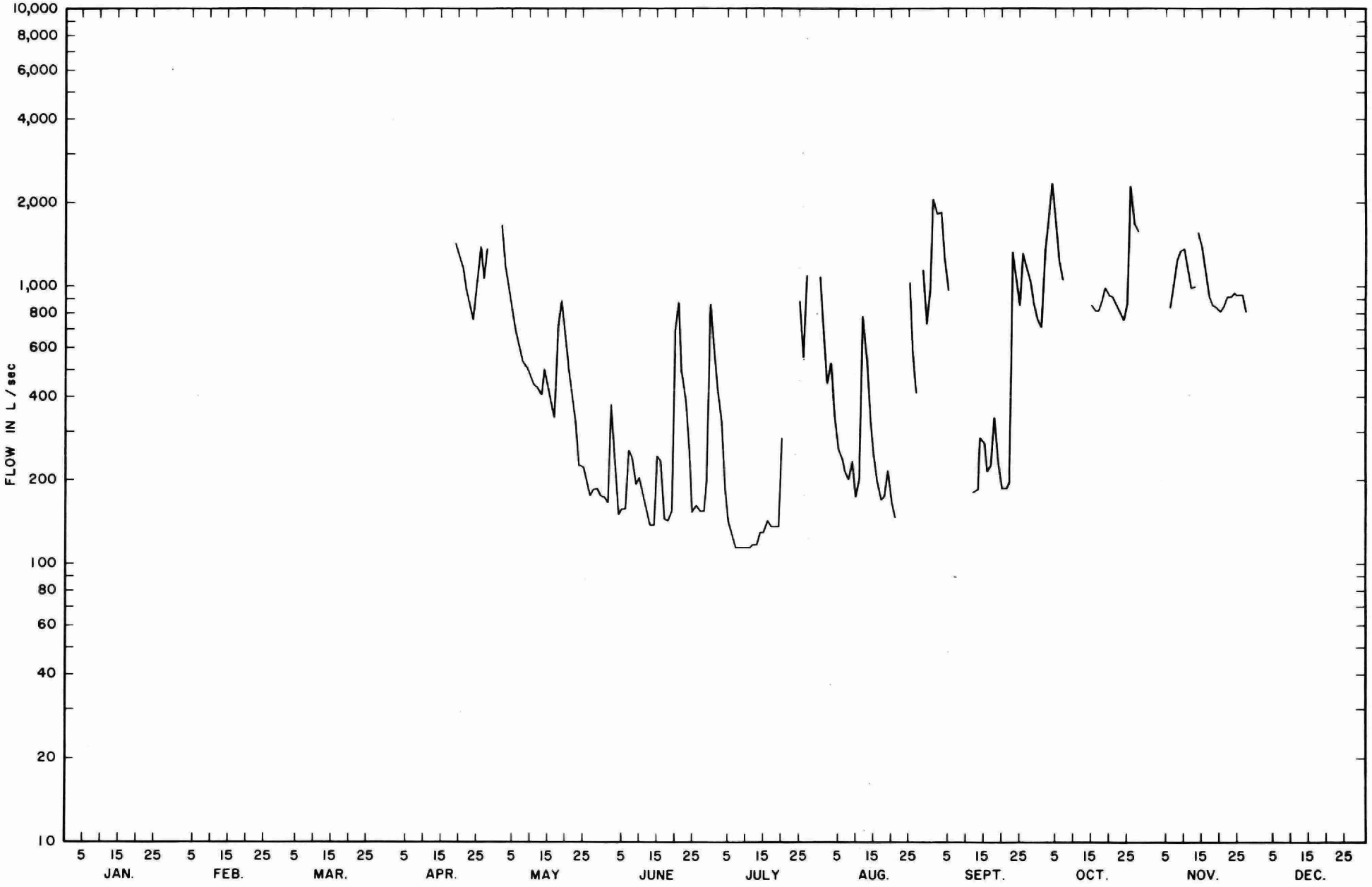

FIGURE 6 - COOKSTOWN-INNISFIL CREEK WATER QUALITY SURVEY, 1980; HYDROGRAPH OF DAILY AVERAGE FLOWS FOR STATION 02ED110 ON INNISFIL CREEK NEAR COOKSTOWN; 1980.

The hydrograph for Station 02ED109 indicates the frequent occurrence of high flow events throughout the period of record. The shape of the hydrograph did not indicate sudden drops in stream flows normally associated with stream water withdrawals. Therefore, it can be assumed that little or no extractions of the stream flow occurred during the 1980 summer-fall period.

Since the 1980 summer-fall flows were abnormal, then flows less than the recorded minimum flow of 125 L/sec averaged over seven consecutive days (July 7-13) should be expected during subnormal flow years. The estimated annual minimum flow averaged over seven consecutive days for a return period of 20 years (7Q20) at Station 6 (02ED110) is 80 L/sec.

Since the combined maximum rate of extraction between Stations 4 and 6 allowed by permit is 65 L/sec, then there is a potential that these extractions could substantially deplete the flow in Innisfil Creek at Station 6 during years of subnormal stream flows.

CONCLUSIONS

1. Lands within the survey basin are used primarily for agricultural purposes. The only centre of concentrated population is Cookstown (1979 population: 836). No point source discharges to the streams were observed.

2. Both Cookstown and Innisfil Creeks support a fishery consisting mainly of bait fish. The known stream water uses are for cattle watering, irrigation and recreation. Water extracted for irrigation from Innisfil Creek at the combined maximum extraction rate, could be the major portion of the flow during the low flow periods.

3. The waters in both streams were enriched and the cause of this enrichment was probably related to the agricultural land use activities. Bacteria densities were also high. High stream pH's and temperatures found during the survey would render these streams highly susceptible to ammonia toxicity at relatively low concentrations.

4. Cookstown Creek is intermittent and thus is not a suitable receiver for the effluent from the proposed water pollution control plant for Cookstown. Innisfil Creek is more suitable because of the greater flows.

Appendix 1 -- Cookstown-Innisfil Creeks Water Quality Survey, 1980; Water Quality Data

Name of Water Body: Cookstown Creek at Station 1

Date	D.O.	Temp.	BOD_5	Tot. Coli.	Fec. Coli.	Fec. Strep.	Tot. P.	Sol. P.	F.A.	TKN	NO_2	NO_3	T.S.	S.S.	Chl.	Field pH / Lab pH	Cond.
	mg/L	°C	mg/L	——— per 100 ml ———			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ph Units	umhos/cm
15/5/80	10.6	10.0	0.2	1100	28	68	.038	.019	.026	.60	.009	.706	-	-	15.0	7.3 / 8.19	550
30/5/80	13.8	21.5	0.8	320	4	20	.100	.051	.008	.57	.018	.862	-	-	21.0	7.6 / 8.37	500
10/6/80	10.6	9.7	1.0	610	76	120	.027	.002	.002	.66	.012	.748	-	-	8.2	8.1 / 8.07	550
23/6/80	8.7	18.5	0.4	1700	384	288	.129	.094	.020	.76	.013	.477	396	6	12.5	7.8 / 8.05	550
7/7/80*	6.4	14.1	1.0	4600	1390	1140	.267	.200	.030	.83	.012	.497	366	20	14.0	7.6 / 7.94	550
25/7/80	7.2	18.9	1.0	3600	860	1060	.112	.036	.062	.25	.029	1.34	457	26	12.0	8.0 / 8.14	600
6/8/80*	6.0	19.9	1.0	4700	1400	1700	.048	.018	.030	.83	.009	.621	420	9	13.5	- / 1.98	600
20/8/80	7.8	18.5	0.6	2300	340	560	.044	.013	.020	.76	.008	.502	409	10	13.5	- / 8.10	600
Max.	10.6	21.5	1.0	4700	1400	1700	.267	.200	.062	.83	.029	1.34	457	26	21.0	8.1 / 8.4	600
Mean	8.9	16.4	0.8	1690	192	293	.096	.054	.025	.66	.014	.719	410	14	13.7	7.7 / 8.1	562
Min.	6.0	9.7	0.2	320	4	20	.027	.002	.002	.25	.008	.477	366	6	8.2	7.3 / 7.9	500

Appendix 2 -- Cookstown-Innisfil Creeks Water Quality Survey, 1980; Water Quality Data

Name of Water Body: Cookstown Creek at Station 2

Date	D.O.	Temp.	BOD_5	Tot. Coli.	Fec. Coli.	Fec. Strep.	Tot. P.	Sol. P.	F.A.	TKN	NO_2	NO_3	T.S.	S.S.	Chl.	Field pH / Lab pH	Cond.
15/5/80	12.0	10.0	0.4	500	96	36	.037	.019	.024	.55	.009	.586	-	-	35.5	6.8 / 8.29	650
30/5/80	11.6	22.1	0.8	370	12	20	.192	.150	.006	.68	.008	.037	-	-	38.0	8.1 / 8.28	600
10/6/80	11.8	10.0	0.8	1360	300	100	.037	.015	.002	.53	.010	.285	-	-	42.5	7.9 / 8.2	650
23/6/80	10.4	19.1	0.8	1700	820	316	.182	.105	.002	1.01	.021	.669	448	4	37.0	7.8 / 8.14	650
7/7/80*	5.3	16.2	2.0	2300	470	610	.251	.150	.010	1.32	.008	.060	419	12	44.0	7.3 / 7.91	650
25/7/80	7.0	18.0	0.6	6200	1080	1720	.086	.049	.060	1.04	.032	1.91	503	9	33.5	8.0 / 8.15	700
6/8/80*	5.3	19.9	1.2	3100	730	880	.050	.020	.016	.78	.013	.592	472	7	36.0	- / 7.92	750
20/8/80	8.6	19.9	0.8	1500	140	250	.152	.085	.036	.63	.007	.288	441	8	34.0	- / 8.06	700
Max.	12.0	22.1	2.0	6200	1080	1720	.251	.150	.060	1.32	.032	1.91	503	12	44.0	8.1 / 8.3	750
Mean	9.0	16.9	0.9	1520	249	219	.123	.074	.020	.82	.014	.553	457	8	37.6	7.7 / 8.1	669
Min.	5.3	10.0	0.4	370	12	20	.037	.015	.002	.53	.007	.037	419	4	33.5	6.8 / 7.9	600

*Night Run

See Appendix 1 for units

REPT 5-G-2

Appendix 3 -- Cookstown-Innisfil Creeks Water Quality Survey, 1980; Water Quality Data

Name of Water Body: Cookstown Creek at Station 3

Date	D.O.	Temp.	BOD_5	Tot. Coli.	Fec. Coli.	Fec. Strep.	Tot. P.	Sol. P.	F.A.	TKN	NO_2	NO_3	T.S.	S.S.	Chl.	Field pH / Lab pH	Cond.
15/5/80	11.2	12.8	0.6	320	64	72	.038	.003	.034	.52	.007	.27	-	-	33.5	7.5 / 8.27	600
30/5/80	11.0	21.0	0.6	280	84	16	.270	.225	.024	.46	.007	.108	-	-	22.0	7.5 / 8.26	550
10/6/80	10.9	11.0	0.6	520	108	60	.022	.004	.014	.41	.007	.138	-	-	29.5	-- / 8.21	600
23/6/80	8.9	22.0	0.8	520	240	68	.140	.088	.020	.75	.018	.447	422	14	33.0	8.2 / 8.18	600
7/7/80*	6.8	14.5	0.8	1100	140	428	.345	.315	.030	.71	.006	.081	403	24	25.0	7.9 / 7.89	600
25/7/80	7.0	20.0	0.2	1900	1100	810	.136	.048	.076	1.02	.044	1.85	507	41	28.5	8.0 / 8.18	700
6/8/80*	6.3	20.1	1.2	2100	750	530	.093	.009	.038	.73	.016	.494	503	74	28.5	-- / 7.94	650
20/8/80	8.4	21.5	0.8	700	130	220	.053	.011	.040	.59	.009	1.61	431	22	29.0	-- / 8.12	650
Max.	11.2	22.0	1.2	2100	1100	810	.345	.315	.076	1.02	.044	1.85	507	74	33.5	8.2 / 8.3	700
Mean	8.8	17.9	0.7	723	195	144	.137	.088	.034	.65	.014	.625	453	35	28.6	7.8 / 8.1	619
Min.	6.3	11.0	0.2	280	64	16	.022	.003	.014	.41	.007	.081	403	14	22.0	7.5 / 7.9	550

*Night Run

See Appendix 1 for units

REPT 5-G-3

Appendix 4 -- Cookstown-Innisfil Creeks Water Quality Survey, 1980; Water Quality Data

Name of Water Body: Cookstown Creek at Station 4

Date	D.O.	Temp.	BOD_5	Tot. Coli.	Fec. Coli.	Fec. Strep.	Tot. P.	Sol. P.	F.A.	TKN	NO_2	NO_3	T.S.	S.S.	Chl.	$\frac{\text{Field pH}}{\text{Lab pH}}$	Cond.
15/5/80	10.7	10.0	1.2	7100	428	64	.058	.024	.038	.88	.014	.831	-	-	30.5	$\frac{6.5}{8.11}$	600
30/5/80	12.6	20.5	1.2	360	168	20	.303	.240	.048	1.09	.027	.543	-	-	22.5	$\frac{8.1}{8.19}$	600
10/6/80	11.8	10.5	1.0	1100	232	332	.091	.040	.016	.89	.019	.806	-	-	35.5	$\frac{8.1}{8.19}$	600
23/6/80	10.6	19.0	0.6	2500	1110	260	.158	.095	.040	.90	.030	.810	437	6	32.0	$\frac{8.0}{8.17}$	650
7/7/80*	6.4	16.8	1.4	1100	1280	500	.429	.365	.066	1.19	.040	.770	449	20	37.0	$\frac{7.9}{7.99}$	650
25/7/80	6.3	18.5	1.6	5300	760	1180	.145	.061	.166	1.98	.053	1.89	514	18	21.0	$\frac{7.5}{7.85}$	650
6/8/80*	5.8	20.9	1.6	2300	460	1120	.140	.067	.104	1.40	.034	.926	490	17	34.0	$\frac{--}{7.87}$	700
20/8/80	6.6	18.9	1.6	1700	350	240	.172	.126	.096	1.02	.026	.614	453	7	35.5	$\frac{--}{7.96}$	700
Max.	12.6	20.9	1.6	7100	1280	1180	.429	.365	.166	1.98	.053	1.89	514	20	37.0	$\frac{8.1}{8.2}$	700
Mean	8.8	16.9	1.3	1890	482	254	.187	.127	.072	1.17	.030	.899	469	14	31.0	$\frac{7.7}{8.0}$	644
Min.	5.8	10.0	0.6	360	168	20	.058	.024	.016	.88	.014	.543	437	6	21.0	$\frac{6.5}{7.8}$	600

*Night Run

See Appendix 1 for units

REPT 5-G-4

Appendix 5 -- Cookstown-Innisfil Creeks Water Quality Survey, 1980; Water Quality Data

Name of Water Body: Cookstown Creek at Station 5

Date	D.O.	Temp.	BOD_5	Tot. Coli.	Fec. Coli.	Fec. Strep.	Tot. P.	Sol. P.	F.A.	TKN	NO_2	NO_3	T.S.	S.S.	Chl.	Field pH / Lab pH	Cond.
15/5/80	10.0	11.5	1.0	380	40	32	.064	.015	.038	.88	.011	.569	-	-	33.5	7.6 / 8.22	600
30/5/80	10.4	20.5	1.0	240	16	4	.217	.160	.058	.84	.021	.414	-	-	30.0	7.8 / 8.32	600
10/6/80	9.8	11.0	1.0	440	44	72	.080	.046	.044	.72	.016	.474	-	-	33.0	-- / 8.26	600
23/6/80	7.7	19.9	0.6	1350	268	64	.185	.130	.094	.95	.036	.829	427	6	32.0	7.8 / 8.08	600
7/7/80*	6.4	17.0	1.2	950	348	292	.422	.340	.096	.95	.029	.349	447	20	38.0	7.9 / 8.04	650
25/7/80	6.3	19.0	0.2	2900	480	1000	.130	.060	.126	1.63	.059	1.65	480	24	19.5	8.0 / 7.95	600
6/8/80*	6.3	20.4	1.2	2900	270	550	.098	.050	.054	1.18	.030	.900	490	17	30.5	-- / 7.98	700
20/8/80	7.0	19.7	0.8	600	210	140	.088	.050	.058	.88	.014	.476	451	10	36.0	-- / 8.18	650
Max.	10.4	20.5	1.2	2900	480	1000	.422	.340	.126	1.63	.059	1.65	490	24	38.0	8.0 / 8.3	700
Mean	8.0	17.4	0.9	845	128	104	.160	.106	.071	1.00	.027	.708	459	15	31.6	7.8 / 8.1	625
Min.	6.3	11.0	0.2	240	16	4	.064	.015	.036	.72	.011	.349	427	6	19.5	7.6 / 8.0	600

*Night Run

See Appendix 1 for units

REPT 5-G-5

Appendix 6 -- Cookstown-Innisfil Creeks Water Quality Survey, 1980; Water Quality Data

Name of Water Body: Cookstown Creek at Station 6

Date	D.O.	Temp.	BOD_5	Tot. Coli.	Fec. Coli.	Fec. Strep.	Tot. P.	Sol. P.	F.A.	TKN	NO_2	NO_3	T.S.	S.S.	Chl.	Field pH / Lab pH	Cond.
15/5/80	11.2	12.0	1.0	220	32	44	.048	.009	.042	.80	.010	.490	-	-	35.0	7.6 / 8.34	600
30/5/80	11.0	20.0	1.0	170	16	8	.221	.155	.034	.78	.016	.259	-	-	32.0	7.6 / 8.36	550
10/6/80	10.8	10.9	0.8	340	64	64	.086	.039	.040	.70	.015	.375			35.5	-- / 8.29	600
23/6/80	8.5	20.0	0.6	640	224	72	.165	.110	.066	.93	.032	.823	445	18	36.5	8.1 / 8.17	600
7/7/80*	6.9	17.0	1.2	1450	408	456	.497	.380	.100	.95	.033	.365	481	73	33.5	8.0 / 8.08	600
25/7/80	6.7	19.5	0.2	2200	410	1010	.130	.054	.116	1.55	.063	1.54	486	38	20.5	8.0 / 8.15	600
6/8/80*	6.6	20.4	1.2	1900	240	500	.100	.043	.052	1.08	.029	.786	498	32	32.0	-- / 8.01	650
20/8/80	7.9	19.8	1.2	1000	110	120	.090	.039	.038	.82	.011	.369	443	22	36.5	-- / 8.23	650
Max.	11.2	20.4	1.2	2200	410	1010	.497	.380	.116	1.55	.063	1.54	498	73	36.5	8.1 / 8.4	650
Mean	8.7	17.4	0.9	686	116	121	.167	.104	.061	.95	.026	.626	471	37	32.7	7.9 / 8.2	606
Min.	6.6	10.9	0.6	170	16	8	.048	.009	.034	.70	.010	.259	443	18	20.5	7.6 / 8.0	550

*Night Run

See Appendix 1 for units

Appendix 7 -- Cookstown-Innisfil Creeks Water Quality Survey, 1980; Water Quality Data

Name of Water Body: Cookstown Creek at Station 7

Date	D.O.	Temp.	BOD_5	Tot. Coli.	Fec. Coli.	Fec. Strep.	Tot. P.	Sol. P.	F.A.	TKN	NO_2	NO_3	T.S.	S.S.	Chl.	Field pH / Lab pH	Cond.
15/5/80	13.4	13.0	1.2	370	44	316	.045	.006	.030	.74	.009	.376	-	-	34.5	7.6 / 8.40	600
30/5/80	11.4	22.0	1.0	800	104	52	.246	.165	.040	.81	.013	.167	-	-	31.0	7.7 / 8.37	550
10/6/80	10.5	11.0	0.8	520	104	184	.099	.026	.036	.75	.014	.286			33.5	-- / 8.25	600
23/6/80	8.8	21.8	0.8	2100	596	164	.166	.095	.058	.91	.032	.698	439	22	34.5	8.3 / 8.20	600
7/7/80*	6.5	17.0	1.6	1350	1410	580	.432	.300	.092	1.05	.032	.312	477	83	31.0	-- / 8.09	600
25/7/80	6.4	20.0	0.2	4200	900	3000	.145	.054	.124	1.50	.059	1.55	496	49	21.5	8.0 / 8.00	600
6/8/80*	6.5	20.6	1.0	1700	440	1010	.088	.034	.044	.95	.026	.739	504	35	30.5	-- / 7.97	700
20/8/80	7.8	20.2	1.2	2900	330	140	.085	.032	.044	.82	.011	.359	452	27	35.0	-- / 8.17	650
Max.	13.4	22.0	1.6	4200	1410	3000	.432	.300	.124	1.50	.059	1.55	504	83	35.0	8.3 / 8.4	700
Mean	8.9	18.2	1.0	1320	292	324	.163	.089	.058	.94	.024	.561	474	43	31.4	7.9 / 8.2	612
Min.	6.4	11.0	0.2	370	44	52	.045	.006	.030	.74	.009	.167	439	22	21.5	7.6 / 8.0	550

*Night Run

See Appendix 1 for units

REPT 5-G-7

Appendix 8 -- Cookstown-Innisfil Creeks Water Quality Survey, 1980; Water Quality Data

Name of Water Body: Cookstown Creek at Station 8

Date	D.O.	Temp.	BOD_5	Tot. Coli.	Fec. Coli.	Fec. Strep.	Tot. P.	Sol. P.	F.A.	TKN	NO_2	NO_3	T.S.	S.S.	Chl.	Field pH / Lab pH	Cond.
15/5/80	12.5	13.0	1.0	1000	116	28	.035	.006	.052	.725	.012	.698	-	-	37.0	8.1 / 8.30	650
30/5/80	9.6	23.0	1.0	280	64	28	.191	.135	.038	.75	.012	.268	-	-	31.0	7.7 / 8.34	600
10/6/80	10.4	11.5	1.0	800	204	108	.071	.022	.040	.67	.014	.336	-	-	33.5	-- / 8.23	600
23/6/80	8.2	23.8	0.8	800	296	104	.374	.260	L.002	1.13	.035	.885	460	31	38.0	7.9 / 8.11	650
7/7/80*	7.2	16.0	1.4	1900	1240	392	.380	.270	.064	1.02	.028	.331	472	68	33.0	-- / 8.02	600
25/7/80	4.6	20.8	0.8	5500	980	2340	.198	.071	.204	1.83	.080	1.67	500	65	22.0	8.1 / 7.81	600
6/8/80*	5.9	20.7	1.2	1800	510	850	.128	.028	.052	1.15	.038	1.32	570	56	33.0	-- / 7.84	750
20/8/80	8.0	22.5	1.6	1500	940	290	.210	.033	.066	1.20	.018	.439	570	112	37.0	-- / 8.14	700
Max.	12.5	23.8	1.6	5500	1240	2340	.380	.270	.204	1.83	.080	1.67	570	112	38.0	8.1 / 8.3	750
Mean	8.3	18.9	1.1	1220	357	194	.198	.103	.065	1.059	.030	.743	514	66	33.0	8.0 / 8.1	644
Min.	4.6	11.5	0.8	280	64	28	.035	.006	L.002	.67	.012	.268	460	31	22.0	7.7 / 8.1	600

*Night Run

See Appendix 1 for units

REPT 5-G-8

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